



EFFECT OF TYPES OF WATER WITH VARIOUS MORTARS

*T. Raghunathan¹ | P. Ganesan² | Gopiraja²

¹ Lecturer, Civil Engineering, P.A.C. Ramasamy Raja Polytechnic College, Rajapalayam, Tamil nadu -626108, India,

² Third year Student, Civil Engineering, P.A.C. Ramasamy Raja Polytechnic College, Rajapalayam-626108, India.

ABSTRACT

In this paper a basic research on effect of mixing of various types of waters, viz. Reverse Osmosis drinking water (RO), Reverse Osmosis Brine water (ROB) and bore water (B) on Cement Mortar (CM), Fly ash Lime Gypsum (FALG) mortar and Alkali activated material (AAM) mortars was studied for properties such as density, water absorption and compressive strength after 7 days and 28 days of curing. Cement mortars give high strength when compared to FALG and AAM mortars.

KEYWORDS: Reverse osmosis, cement mortar, Brine, bore water, FALG, Alkali activated material, compressive strength.

INTRODUCTION:

Water is a basic construction material which is highly neglected during construction. The quantity and quality of water affects the properties of both mortar and concrete. Hence a detailed analysis and design must be done on properties of mortar and Concrete with various types of water. If the quantity of water increases then the compressive strength decreases and porosity increases. The various deleterious salts interfere with the quality of mortar and Concrete.

P. Samuthirapandiyan, et al.,^[1] investigated about effect of sea water and strength of concrete, they used sea water both for casting and curing. Falah M. Wegian^[2] investigated Effect of seawater for mixing and curing on structural concrete, observed that, The reduction in strength increases with an increase in exposure time, which may be due to salt crystallisation formation affecting the strength gain. Kazi P. Fattah, et al.,^[3] used desalination brine water with ggbs for concrete and observed that, the use of GGBS and reject brine improved the strength of concrete produced by 16.5%. Replacing 50% of the cement with GGBS and using reject brine as the source of water has a potential for reducing 176 kg CO₂ and 1.7–3.4 kg of CO₂ equivalents per one cubic meter of concrete, respectively. Adel Younis, et al.,^[4] studied fresh and hardened properties of sea water mixed concrete and observed that Mechanical performance of seawater concrete was slightly lower than that of the freshwater-mixed concrete. The permeability performance of hardened concrete in the two mixtures was similar. B. Balineer et al.,^[5] observed from their investigations that, the compressive strength of OPC based well-cement increases as the salinity level of the brine water is increased up to 10 % NaCl and that it thereafter decreases as the NaCl percentage is further increased. On the other hand, the compressive strength of Alkali activated material well-cement generally increases as the brine concentration is increased. Based on the findings of this research, it can be concluded that Alkali activated material as a well-cement can perform better in saline water than OPC based well-cement. E.M. Mbadike et al.,^[6] concluded that The use of salt water in concrete production will reduce the strength of concrete produced to approximately 8%. Mrudul Garg et al.,^[7] observed that brine sludge up to 35 and 25% can safely be utilized for making paver blocks and bricks, respectively. The leachability studies confirm that the metals ions and impurities in the sludge are substantially fixed in the matrix and do not readily leach from there. CORPS OF ENGINEERS,^[8] investigated various types of water and its effect on concrete, they found that, samples gave concrete strengths below the strength-ratio of 85 per cent which was considered the lower limit for acceptable mixing waters: acid waters, lime soak from tannery, refuse from paint factory, mineral water from Colorado, and waters containing over five per cent of common salt. Preeti Tiwari et al.,^[9] concluded from their studies that, if we use salt water casting and curing the concrete. There is some increase in the strength if salt water is used for casting and curing. This concrete can be used for mass concreting without any decrease in strength properties. Haseeb Khan et al.,^[10] concluded from their studies that, There is no remarkable reduction in compressive strength due to mixing of saline water and also mixing and curing of concrete with saline water compared to characteristic target strength. Mohamed Anwar et al.,^[11] stated that the use of ternary systems in concrete improved the different characteristics of the product concrete and showed a significant resistance to chloride penetration. Sagar Gawande et al.,^[12] concluded that, There is higher in the strength of concrete specimen cast & cured with salt water as compared to those of cast & cured in fresh water. The rate of the strength gain in fresh water cubes is slow as compared with salt water.

A. Sumathi, et al.^[13] studied fly ash bricks with quarry dust and concluded that maximum optimized compressive strength is obtained for optimal mix percentage of Flyash-15% Lime-30% Gypsum-2% Quarry dust-53%.

Syahrir Ridha, et al.,^[14] in their investigation concluded that Alkali activated material samples experiences strength reduction in brine water but the reduction rate of Alkali activated material is about half of the OPC based oil well cement. Haider M. Giasuddin, et al.,^[15] used Alkali activated material with sea water in ambient curing conditions and found that Alkali activated material based cements cured in saline water showed higher strength results than the ones cured in normal water. M. OLIVIA et al.,^[16] studied cyclic exposure of Alkali activated material and OPC concrete to sea water and concluded that the Alkali activated material concrete was found to perform better under cyclic exposure than the OPC concrete in compressive strength. J. J. Ekaputri et al.,^[17] concluded from their studies that During 90 days exposure in salt-water, fly ash-based Alkali activated material concrete made with 12 M NaOH gain higher strength faster than that with lower concentration. Alkali activated material concrete has higher compressive strength than OPC in salt water. It proves that Alkali activated material concrete is durable in aggressive environment because there is abundance of Na⁺ in salt. Monita Olivia et al.,^[18] study on the durability of fly ash Alkali activated material concrete in a seawater environment, concluded that, fly ash Alkali activated material concrete indicated severe corrosion under half-cell potential measurement, a minor corrosion activity and time to failure in relationship to the OPC concrete was observed under the accelerated corrosion test.

TEST PROCEDURE:

For manufacturing Cement mortar, RAMCO Portland pozzolana cement and M. Sand was used in the ratio of 1:3. The water cement ratio was maintained as 0.5. For each batch 6 cubes were cast and 3 were tested after 7 days water curing and another set of 3 cubes were tested after 28 days water curing.

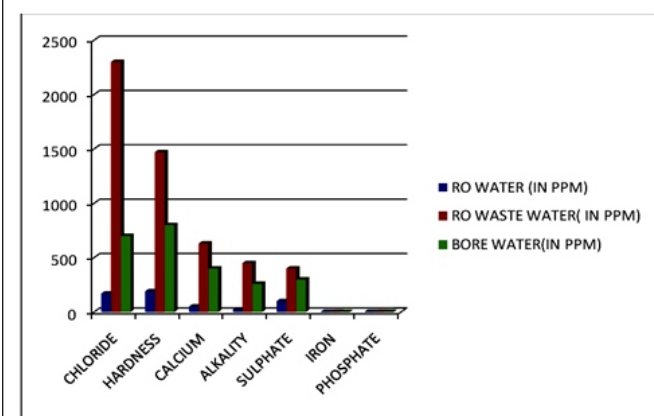
For manufacturing FALG mortar, Fly ash from Tuticorin Thermal power plant was used. Commercial Lime and Gypsum was procured from local vendors. The Fly ash was taken as 65%, lime 30% and gypsum 5%. Water FALG ratio was maintained as 0.5. The mortar was made with FALG to M Sand ratio as 1:3. For each batch 6 cubes were cast and 3 were tested after 7 days water sprinkling curing and another set of 3 cubes were tested after 28 days water sprinkling curing.

For manufacturing Alkali activated material mortar, Sodium hydroxide 10 mole solution was made using commercial sodium hydroxide with various types of water for each batch. Sodium silicate was added as 2.5 times the weight of sodium hydroxide. The solution was prepared 24 hours before casting date. The ratio of activator solution to fly ash was maintained as 1:3. The paste made from mixing activator solution and fly ash was then mixed with M. Sand in the ratio of 1:3. For each batch 6 cubes were cast and 3 were tested after 7 days ambient curing and another set of 3 cubes were tested after 28 days ambient curing.

TEST RESULTS:

Table 1: Water Test Results

TYPE OF TEST	RO WATER (IN PPM)	RO WASTE WATER (IN PPM)	BORE WATER (IN PPM)
1. CHLORIDE	170	2300	700
2. HARDNESS	190	1470	800
3. CALCIUM	50	630	400
4. ALKALITY	20	450	260
5. SULPHATE	200(below)	200(below)	200(above)
6. IRON	0.6	1	0.6
7. PHOSPHATE	0.5	1	1



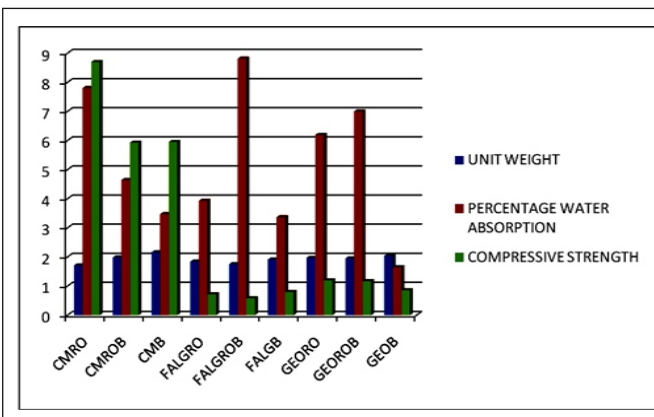
Note: RO-Reverse Osmosis

Discussion for water results:

1. The RO brine water has more chlorides, hardness, sulphate, than bore water
2. RO water has very less values of all salts
3. Bore water exceeds the limits specified in IS 456:2000

Table 2: Mortar Cubes 7 Days Results

MIX	UNIT WEIGHT	PERCENTAGE WATER ABSORPTION	COMPRESSIVE STRENGTH
CMRO	1.71	7.8	8.7
CMROB	1.98	4.64	5.93
CMB	2.16	3.47	5.95
FALGRO	1.84	3.93	0.72
FALGROB	1.75	8.81	0.58
FALGB	1.91	3.36	0.8
GEORO	1.97	6.19	1.2
GEOROB	1.95	7.0	1.17
GEOB	2.04	1.65	0.86



Note:

1. CMRO-Cement mortar with RO water
2. CMROB:-Cement mortar with Reverse osmosis brine water
3. CMB:Cement water with bore water
4. FALG-Fly ash lime gypsum
5. GEO:-Alkali activated material (geopolymer)

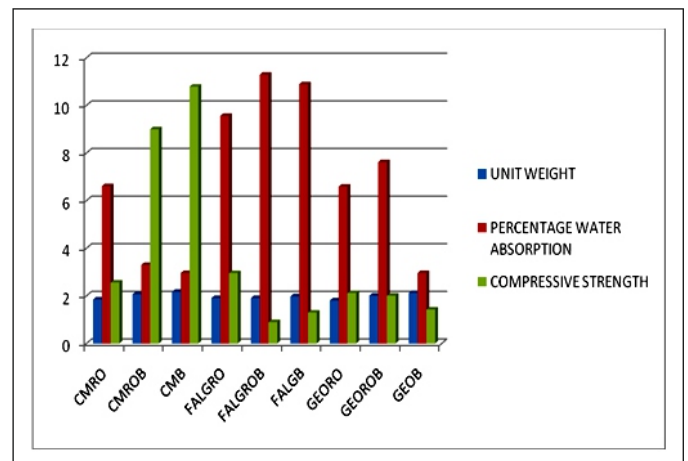
Discussion for 7 days results:

1. The unit weight has values near to 2 gms/cc for all samples
2. The Cement mortar shows higher strength than FALG and Alkali activated material mortars, The Alkali activated material mortar shows more strength than FALG. FALG mortar is the weakest.

3. RO water gives highest strength with CM.
4. Bore water gives highest strength for FALG
5. RO and RO waste water shows almost same strength in Alkali activated material Mortars
6. Even though strength is less, but Bore water gives less water absorption with FALG and Alkali activated material mortars, which is a desirable property for construction products.
7. The low strength of FALG is due to slow strength attaining character of lime and the cubes are not machine pressed but hand compacted.
8. The low strength of Alkali activated material is due to absence of Metakaolin and Heat curing. Table 3: Mortar Cubes 28 Days Results

Table 3: Mortar Cubes 28 Days Results

MIX	UNIT WEIGHT	PERCENTAGE WATER ABSORPTION	COMPRESSIVE STRENGTH	CPWD grade
CMRO	1.85	6.61	2.56	M7.5
CMROB	2.07	3.30	9.00	M7.5
CMB	2.17	2.96	10.79	M7.5
FALGRO	1.91	9.56	2.96	M0.5
FALGROB	1.91	11.29	0.9	M0.5
FALGB	1.98	10.89	1.3	M0.5
GEORO	1.81	6.59	2.12	--
GEOROB	2.01	7.62	2.01	--
GEOB	2.12	2.96	1.43	--



Discussion for 28 days results:

1. The strength of FALG RO mortar and Alkali activated material RO & RO brine mortars has doubled from 7 days results
2. The higher water absorption corresponds to low strength of mortar cubes.
3. The density is same as 7 days results with round 2gms/cc
4. The RO Cement mortar shows less value than 7 days which may be erroneous result
5. FALG Bore water mortar samples show better results than FALGRO Brine mortar samples.
6. Alkali activated material RO and RO brine water show almost same compressive strength and water absorption characteristics.

CONCLUSION:

- The RO brine water and Bore water has showed increase in strength in 28 days Cement mortar.
- The unit weight remains same for all samples at 2gms/cc. CMROB and CMB conforms to MM7.5 grade of CPWD Specifications^[19].
- FALG RO, FALGROB, FALGB conforms to grade MM0.7 CPWD specifications.
- The AAM mortar shows reduction in strength with RO brine and bore water,

more than FALG mortar with same type of water. There is no IS code for AAM.

- While others have tried only sea water in their research except for Army Engineers, we have tried RO brine and Bore water.

Future scope:

Durability studies can be done. Ways to improve the strength of FALG and AAM mortars to the level of Cement mortars can be identified.

REFERENCES:

1. B.Sathish kumar1, P.Samuthirapandiyan, K.Sabari rajan, A.Subalakshmi,(2018): "Effect Of Sea Water And Strength Of Concrete", International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 05 Issue: 04 Page 1195-1199
2. Falah M. Wegian (2010) Effect of seawater for mixing and curing on structural concrete, The IES Journal Part A: Civil & Structural Engineering, 3:4, 235-243, DOI: 10.1080/19373260.2010.521048
3. Kazi P.Fattah, Adil K.Al-Tamimi, WaseemHamweyah, FatimaIqbal(2017), "Evaluation of sustainable concrete produced with desalinated reject brine", International Journal of Sustainable Built Environment, Volume 6, Issue 1, Pages 183-190
4. AdelYounis, UsamaEbead, PranneySuraneni, AntonioNanni,(2018) Fresh and hardened properties of seawater-mixed concrete,Elsevier, Construction and Building Materials, Volume 190, Pages 276-286
5. B. Balinee, P. Disaanth and M. C. M. Nasvi,(2018):Comparison of Salinity Dependent Mechanical Behaviours of Alkali activated material and OPC: An Application to CCS and Oil / Gas Wells, Engineer - Vol. LI, No. 03, pp. [13-20], © The Institution of Engineers, Sri Lanka
6. E.M. Mbadikea, A.U. Elinwab,(2011) : Effect Of Salt Water In The Production Of Concrete, Nigerian Journal Of Technology Vol. 30, No. 2, , pp105-110
7. Mridul Garg and Aakanksha Pundir,(2014) : Utilization of Brine Sludge in Nonstructural Building Components: A Sustainable Approach, Hindawi Publishing Corporation Journal of Waste Management, Article ID 389316, 7 pages <http://dx.doi.org/10.1155/2014/389316>
8. Army Engineers(1956): Requirements For Water For Use In Mixing Or Curing Concrete, Technical Report No. 6-440 November 1956, Waterways Experiment Station Corps of Engineers, U. S. Army Vicksburg, Mississippi.
9. Preeti Tiwari et al. (2014): Effect Of Salt Water On Compressive Strength Of Concrete, Int. Journal of Engineering Research and Applications, ISSN : 2248-9622, Vol. 4, Issue 4(Version 5), pp.38-42
10. Haseeb Khan, Abdul Ahad, Tabish Izhar,(2016):Effect of Saline Water in Mixing and Curing on Strength of Concrete, IJSART - Volume 2 Issue 5, ISSN [ONLINE]: 2395-1052, pp. 313-317
11. Mohamed Anwar, Mahmoud Roushdi, (2013):Improved concrete properties to resist the saline water using environmental by-product, Water Science, Volume 27, Issue 54, Pages 30-38
12. Prof. Sagar Gawande,Prof. Yogesh Deshmuk,Mr. Milind Bhagwat,Mr. Suhas More, Mr.Namdev Nirwal, Mr. Akshay Phadatare, (2017): Comparative Study of Effect of Salt Water and Fresh Water on Concrete, International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 04 Issue: 04.
13. A. Sumathi, K. Saravana Raja Mohan,(2015) Compressive Strength of Fly Ash Brick with Addition of Lime, Gypsum and Quarry Dust, International Journal of ChemTech Research Coden (USA): IJCRGG ISSN: 0974-4290 Vol.7, No.01, pp 28-36.
14. Syahrir Ridha, Afif Izwan Abd Hamid, Che Ku Afiza Hanim Che Ku Mazuan,(2018) "Influence of different brine water salinity on mechanical properties of fly ash-based Alkali activated material cement", International Journal of Structural Integrity 9(12):00-00, DOI: 10.1108/IJSI-04-2017-0023
15. IHaider M.Giasuddin, Jay G.Sanjayan, P.G.Ranjith,(2013): Strength of Alkali activated material cured in saline water in ambient conditions, Elsevier, Fuel, Volume 107, Pages 34-39
16. Olivia, M.; Nikraz, H. (2013):Properties Of Fly Ash Alkali Activated Material Concrete In Seawater Environment, Proceedings of the Thirteenth East Asia-Pacific Conference on Structural Engineering and Construction (EASEC-13), September 11-13, , Sapporo, Japan, D-6-6., D-6-6
17. J J Ekaputri et al,(2019): The effect of alkali concentration on chloride penetration in Alkali activated material concrete, IOP Conf. Ser.: Mater. Sci. Eng. 615 012114
18. Olivia, Monita and Nikraz, Hamid R. (2011):Durability of Fly Ash Alkali activated material Concrete in a Seawater Environment, Proceedings of the Concrete 2011 Conference, Oct 12., Perth, WA: The Concrete Institute of Australia.
19. Appendix-G, Vol-2 Mortars, Specifications 91 – 92, Central Public Works Department, India, PP-37.